

STATOR WINDING SYSTEM AND METHOD WITH PALLET ON PALLET ARRANGEMENT

TECHNICAL FIELD

The present invention relates generally to stator manufacturing and,
5 more particularly, to a system and method for winding stators using a winding pallet
on transport pallet arrangement.

BACKGROUND OF THE INVENTION

Stator manufacturing lines have in the past included a conveyor
extending from station to station of the manufacturing process. In some cases
10 winding operations have taken place using machines which remove the stator from the
main manufacturing process lane and send the stator to a winding machine via a
winding machine conveyor lane extending perpendicular to the main manufacturing
process conveyor lane. Such arrangements increase costs and substantially increase
the size of the foot print for the machinery. While arrangements in which the stator
15 winder is placed adjacent the main manufacturing conveyor lane are known as from
U.S. Patent No. 4,713,883, such arrangements are limited in speed and have not
generally been suitable for winding techniques utilizing shrouds. Other known
arrangements utilize an indexing or dial-type arrangement such as that shown in U.S.
Patent No. 5,149,900. However, the indexing arrangement is typically limited in only
20 having four stations and tends to be costly.

Accordingly, it would be advantageous to provide a stator winding
method and system suitable for quickly winding stators at a winding position adjacent
the conveyor lane.

SUMMARY OF THE INVENTION

25 In one aspect, a stator winding method involves the steps of: (a)
providing a transport pallet and a winding pallet, the winding pallet removably
positioned upon the transport pallet; (b) conveying the transport pallet with winding
pallet thereon along a conveyor in a substantially horizontal first direction to an input
side of a winding station; (c) raising the transport pallet with winding pallet thereon
30 above the conveyor; (d) holding the winding pallet in place as the transport pallet is
lowered so as to separate the winding pallet from the transport pallet; (e) laterally
moving the winding pallet in the first direction and into a first pivot arm; (f) pivoting

the winding pallet through substantially ninety degrees to a first position alongside a winding position; (g) laterally moving the winding pallet in the first direction out of the first pivot arm and into the winding position; (h) performing a winding operation at the winding position; (i) laterally moving the winding pallet in the first direction
5 into a second position alongside the winding position and into a second pivot arm; (j) pivoting the winding pallet through substantially ninety degrees to a position above the conveyor; (k) laterally moving the winding pallet in the first direction out of the second pivot arm and into a pallet combining position and holding the winding pallet in the pallet combining position; (l) laterally moving the transport pallet along the
10 conveyor into a position below the pallet combining position; (m) raising the transport pallet up into contact with the winding pallet; (n) releasing the winding pallet so as to rest upon the transport pallet; and (o) lowering the transport pallet with winding pallet thereon back onto the conveyor.

In another aspect, a stator winding method involves the steps of: (a)
15 providing a transport pallet and a winding pallet, the winding pallet removably positioned upon the transport pallet; (b) conveying the transport pallet with winding pallet thereon to an input side of a winding station; (c) separating the transport pallet from the winding pallet; (d) pivoting the winding pallet into a first position alongside a winding position; (e) laterally moving the winding pallet into the winding position;
20 (f) performing a winding operation at the winding position; (g) laterally moving the winding pallet into a second position alongside the winding position; (h) pivoting the winding pallet away from the second position and into a third position; and (i) placing the winding pallet back onto the transport pallet

In a further aspect, a stator winding system for conveying and winding
25 a stator mounted on a winding pallet is provided, the winding pallet removably positioned on a transport pallet. The system includes a conveyor, a pallet separation station at an upstream side of a winding machine; and an elevator below the pallet separation station, the elevator lifting the transport pallet with winding pallet thereon off the conveyor and up to the pallet separation station. A pair of gripping arms are
30 provided for moving into a holding arrangement with the winding pallet at the pallet separation station. An upstream pivot arm is positioned adjacent the pallet separation station for receiving the winding pallet from the pair of gripping arms and pivoting the

0935298-082201

winding pallet through substantially ninety degrees to a position upstream of a winding position of the winding machine.

In yet another aspect, a stator winding system for conveying and winding a stator mounted on a winding pallet is provided, the winding pallet
5 removably positioned on a transport pallet. The system includes a conveyor for transporting the transport pallet with winding pallet thereon. An elevator is movable between a low position and a raised position above the conveyor. A pair of gripping arms are provided at the raised position for holding the winding pallet. A pivot arm is provided for holding the winding pallet and pivoting the winding pallet between at
10 least first and second positions, the first position adjacent the raised position.

In still a further aspect, a stator winding system includes a transport pallet and a winding pallet removably positioned on the transport pallet. The winding pallet is formed by a plate member including an aperture having a stator mounted therein. The aperture permitting access to top and bottom sides of the stator when the
15 winding pallet is removed from the transport pallet.

In another aspect, a system for use with a stator mounted on a winding pallet is provided, the winding pallet removably positioned on a transport pallet. The system includes a conveyor for transporting the transport pallet with winding pallet thereon, means for separating the winding pallet from the transport pallet and means
20 for pivoting the separated winding pallet between at least first and second positions, the second position being upstream of a winding position of a winding machine.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an isometric view of a pallet on pallet arrangement;
Fig. 2A is a front elevation of the arrangement of Fig. 1;
25 Fig. 2B is a side elevation of the arrangement of Fig. 1;
Fig. 3 is a front elevation of another pallet on pallet arrangement;
Fig. 4 is a perspective, schematic view illustrating the movement operations in accordance with one embodiment of a stator winding system and method;
30 Fig. 5 is an elevation view of positions 70 and 74 of Fig. 4;
Fig. 6 is a top view of positions 74 and 78 of Fig. 4;
Fig. 7 is a side elevation of Fig. 6;

Fig. 8 is an elevation view of one embodiment of a pivot arm pivot arrangement;

Fig. 9 is an elevation view of position 82 of Fig. 4;

Fig. 10 is a top view of positions 82, 84 and of Fig. 4. and

Fig. 11 is a partial perspective view of a downstream pivot arm and downstream gripping arms.

DETAILED DESCRIPTION

Referring to Figs. 1, 2A and 2B, a stator pallet or pallet arrangement 10 is shown and includes a transport pallet 12 and a winding pallet 14 removably positioned on the transport pallet 12. The winding pallet 14 may be formed of a plate member having an aperture 16 in which a stator may be mounted or held via suitable means such as clamping arms 18 and 20. Clamping arm 18 may be fixed while clamping arm 20 may be resiliently biased inward against the stator 22 positioned therein and may also be adjustable. The plate member of the winding pallet 14 may include a plurality of wire retaining studs 24 extending from a top surface thereof for temporarily securing wires. The studs 24 may be formed by a fixed lower part 26 and a downwardly biased (via spring for example) but movable upper part 28 so that wires can be moved into position between the two and held by the downward biasing of the upper part 28. One or more additional holes 29 in the upper and/or lower surface of the plate member may be provided and may, for example, be used to facilitate positioning of the winding pallet 14 at various stages of system operation.

The transport pallet 12 includes a plurality of posts 30 extending upwardly therefrom for supporting the winding pallet 14. In this regard, at least two or more of the posts 30 may be formed to include an upper positioning portion 32 smaller in diameter than a lower portion 34 to aid in assuring that the winding pallet 14 maintains a desired position on the transport pallet 12. For this purpose the winding pallet 14 may include a corresponding plurality of openings 36 formed thereon for receiving upper post portions 32 therein, with the structure defining the perimeter of each opening 36 resting upon an upper surface of post portion 34. In the illustrated embodiment openings 36 may be formed by bushings 38 which are press fit into holes in the plate member of the winding pallet 14. Alternatively, the openings 36 could be defined by the plate member itself. It is also recognized, that an

alternative arrangement may include posts extending from the winding pallet 14 and received in openings on the transport pallet 12.

5 A positioning die or detail 40 attached to the transport pallet 12 is provided for supporting the stator 22 at a certain position (such as a desired reference position for manufacturing operations) relative to the winding pallet 14 when the winding pallet 14 is positioned on the transport pallet 12. In the illustrated embodiment the positioning die 14 is generally rectangular in shape having a narrow width in front view and a relatively larger width in side view. It is recognized that other shapes are possible and that in some cases the positioning die could be formed unitary with the transport pallet 12.

A more detailed depiction of one embodiment of a winding pallet 14 on transport pallet 12 arrangement 42 is illustrated in Fig. 3.

Referring now to the system schematic of Fig. 4, an explanation of one embodiment of a stator winding operation useful in conjunction with a stator which is mounted in a winding pallet 14 which in turn is removably positioned on a transport pallet 12 is described. The system 50 includes a stator winding machine 52 positioned alongside a manufacturing line 54. The line 54 may be formed by three conveyor lanes 56, 58 and 60. Lanes 56 and 58 are working lanes of the line 54 and carry stator pallet arrangements 10 in a work flow direction defined by arrows 62. A complete manufacturing system may include a plurality of winding machines and other stations along the line 54. At various points along the line 54 suitable means may be provided for transferring stator pallet arrangements 10 back and forth between lanes 56 and 58. Lane 60 represents a return flow lane moving in an opposite direction 64 which may be used to return transport pallets 12 back to the front of the line 54.

25 An exemplary stator winding method is now described. In particular, a transport pallet is with winding pallet 14 removably positioned thereon is conveyed down conveyor lane 56 in substantially horizontal direction 62 to an input side of a winding station or machine 52 until position 70 is reached. The conveyor lane 56 is stopped and the transport pallet with winding pallet thereon is raised above the conveyor lane 56 as indicated by arrow 72 to a pallet separation station defined by position 74. The winding pallet 14 is held in place at the pallet separation station 74 as the transport pallet 12 is lowered so as to separate the winding pallet 14 from the

transport pallet 12. The winding pallet 14 is then laterally moved as indicated by arrow 76 into an upstream pivot arm located at position 78. The winding pallet 14 is then pivoted upward through substantially ninety degrees as indicated by arrow 80 to an upstream position 82 alongside a winding position 84 of the winding machine 52.

5 The winding pallet 14 is laterally moved out of the upstream pivot arm and into the winding position 84 as indicated by arrow 86. A winding operation is performed on the stator in the winding pallet 14 at the winding position 84. The winding pallet 14 is then laterally moved into a downstream position 88 alongside the winding position 84 and into a downstream pivot arm at position 88 as indicated by arrow 90. The
10 winding pallet 14 is then pivoted downward through substantially ninety degrees as shown by arrow 92 to a position 94 above the conveyor lane 56. The winding pallet 14 is then laterally moved of the downstream pivot arm and into a pallet combining position 96 as indicated by arrow 98, and the winding pallet 14 is held in the pallet combining position 96. By the time the winding pallet 14 reaches position 96, the
15 transport pallet 12 has been conveyed along the conveyor lane 56 into a position 100 below the pallet combining position 96 as indicated at 102. The transport pallet 12 at position 100 is raised up into contact with the winding pallet 14 at position 96 such that the winding pallet 14 is again properly positioned on the transport pallet 12. The winding pallet 14 is then released so as to rest upon the transport pallet 12; and the
20 transport pallet 12 with winding pallet 14 thereon is lowered back down onto the conveyor lane 56 at position 100 where the arrangement can be moved further down the manufacturing line 54 for further manufacturing operations. It is noted that in the illustrated embodiment all lateral moves 76, 86, 90 and 98 of the winding pallet are in the same direction 62 as conveyor lane 56.

25 Exemplary structures which may be utilized to construct a system 50 which operates as described above are now explained with reference to Figs. 5-11. Referring first to Fig. 5, a partial elevation view along conveyor lane 56 with direction 62 into the page is depicted. As shown, conveyor lane 56 may be formed by spaced apart, movable conveyor rails 110 which may be supported by suitable structure 112
30 mounted to a frame 114 of the conveyor line. Also mounted to frame 114 is an elevator or lift mechanism 116 which is operable to move upward between the rails 110 into contact with a bottom portion of transport pallet 12 for lifting the transport

1022280 0625260

pallet 12 and conveyor pallet 14 upward into the pallet separation station 74. In an alternative embodiment the elevator could grasp the transport pallet from one or both sides for lifting to the pallet separation station 74. The transport pallet 12 and winding pallet 14 are shown in dashed lines at both positions, that is, on the conveyor lane 56 and at the pallet separation station 74. In one embodiment the elevator mechanism may take the form of a linearly actuatable pneumatic cylinder assembly 118. An upper portion 120 of the assembly 118 which contacts the transport pallet 12 may take various forms, from that of a simple flat plate to more complex forms which may include positioning posts 122 for engaging corresponding openings on the bottom of transport pallet 12 in order to maintain desired positioning. Regardless of the exact form, when the pneumatic cylinder assembly 118 is actuated the transport pallet 12 and winding pallet 14 are moved upward toward the pallet separation station 74. In this regard, a suitable sensor such as a proximity switch or optical switch may be used to indicate when the pallet arrangement 10 is at the desired position 70 below the pallet separation station 74. For example, in an exemplary Bosch conveyor line a pallet stop gate such as an air-actuated pivoting arm may be normally positioned in an up state between the conveyor rails 110 for stopping the transport pallet and winding pallet combination and may include a proximity switch or other sensor for determining when a pallet is in position 70. The conveyor rails 110 continue moving, sliding relative to the stopped transport pallet. The transport pallet and winding pallet can then be elevated and separated. Once the winding pallet is separated and the transport pallet lowered back onto the conveyor lane 56, the stop-gate may be actuated to a down position to allow the transport pallet to move to downstream position 100. Thus, in the illustrated embodiment the combination of the elevator and the gripping arms act as a pallet separation means.

Also mounted to the frame 114 are support brackets 130 which extend upward along the outer side of each conveyor rail 110. At the top of each bracket 130 a plate portion 132 is provide for the mounting of gripping arms 134 which are moveable inward as indicated by arrows 136. The gripping arms 134 form a pair of opposed slots 138 which are sized and positioned for moving into a supporting or holding arrangement with the side edges of the plate member of winding pallet 14. The supporting or holding arrangement prevents the winding pallet 14 from moving

downward back to the conveyor lane 56 but may permit lateral sliding of the winding pallet in opposed slots 138. The gripping arms 134 may be movable via associated pneumatic assemblies 140. Once the gripping arms 134 are moved into a holding position of the winding pallet 14, the elevator 116 may be lowered to separated the transport pallet 12 from the winding pallet 14. The stator 22, of course, stays with the winding pallet 14 upon such separation. The plate portions 132 may include biasing means such as movable, spring-loaded pins 142 which contact a portion of the transport pallet 12 when the transport pallet 12 is in its most upward position. The biasing means provides a small downward force on the transport pallet 12 to help assure separation of the transport pallet 12 from the winding pallet 14 when the elevator 116 is lowered. Suitable proximity switches or other sensors may be used to provide control signals indicating the elevator up position, elevator down position, gripping arms inward position and gripping arms outward position.

Referring now to Fig. 6 a top view of separation station 74 and adjacent position 78 is shown. In the illustrated embodiment the gripping arms 134 are shown slightly staggered. Upstream of the separation station 74 a support 150 is mounted laterally to the two plate portions 132. Mounted to the support 150 are two linear actuators 152 and 154 which may also take the form of suitable pneumatic cylinder assemblies. As shown in the side elevation of Fig. 7 the elevation of the actuators 152 and 154 may be offset. The upper actuator 152 includes an actuator member 156 which may take the form of a rod end or a push bar which is aligned for contacting and moving the winding pallet 14 from the separation station 74 into adjacent position 78 where a pivot arm 160 is positioned for receiving the winding pallet for subsequent pivot of the winding pallet about pivot axis 162. The lower actuator 154 may move a fork type member 158 or other structure into position between the winding pallet 14 and the transport pallet 12 before the transport pallet is lowered back onto the conveyor lane 56. When beneath the stator in the winding pallet 14 the fork type member or other structure forming part of actuator 154 prevents supports the stator relative to the winding pallet 14 and prevents the insulation member from dropping out of the stator when the transport pallet 12 is lowered. In this regard, it is contemplated that the transport pallet 12 may be aligned such that the die member 40 is positioned lengthwise relative to direction 62, easily allowing the

two sides of the fork type member 158 to move along both sides of the stator in the winding pallet 14. Suitable proximity switches or other sensors may be used for control purposes as indicators of the actuator 154 extended position, actuator 154 retracted position, actuator 152 extended position, actuator 152 retracted position and
5 pallet in arm 160 position.

A similar gripping arm arrangement may be located at the downstream side of the winding machine 52 at position 96 for receiving and holding the winding pallet 14 after winding. A similar elevator mechanism 116 may also be provided at position 100 for raising the transport pallet 12 up into engagement with the winding
10 pallet 14. Of course, at the downstream side there would be no need for the pallet separating biasing means 142 on the underside of the plate portions 132.

Additionally, there would be no need for an actuator such as 154 because after winding the insulation will not fall off the stator assembly. Further, while the upstream arrangement shows a push-type linear actuator 152 mounted immediately
15 adjacent the gripping arms 134, at the downstream side a similar push-type linear actuator used for moving the winding pallet 14 from the downstream pivot arm to the downstream gripping arms would be mounted to a frame or bracket just upstream of the downward pivot location 94 of the downstream pivot arm.

One embodiment of an exemplary pivot arrangement suitable for the
20 pivot arm 160 is shown in the upstream looking side elevation of Fig. 8. It is recognized that this same arrangement could be provided for the downstream pivot arm 164 (Fig. 10). It is also recognized that the upstream and downstream pivot arms 160 and 164 could have differing pivot arrangements. For example, the downstream pivot arm 164 could pivot via the arrangement of Fig. 8 while the upstream pivot arm
25 160 could be pivoted by a rotational actuator such as a rotating motor with gearing or belt arrangement. The exact mode of pivot is not necessarily critical. Referring again to the arrangement of Fig. 8, the pivot arm 160 or 164 is mounted about a pivot axis 162 and includes lever arm 170. One side of the lever arm 170 is associated with the pallet gripping portion of the arm and the opposite side of the lever arm 170 is
30 pivotally associated with a linear actuator 172 such as the rod of a pneumatic cylinder assembly 174. When the linear actuator 172 is extended in direction 176 the pivot arm pivots about axis 162 through ninety degrees to an upright position shown in

shadow. It is noted that an axis 23 of the stator 22 is substantially vertical when the arm is pivoted downward into position above the conveyor lane 56 and the axis 23 is substantially horizontal when the arm is pivoted upward into position adjacent the winding position 84. The upright position corresponds to position 82 for an upstream pivot arm and position 88 for a downstream pivot arm. In either case, when in such upright position opposed slots 176 formed on the pivot arm align with opposed slots 178 formed at the winding position 84 (Fig. 4) of winding machine 52 permitting the winding pallet 14 to be easily slid from upstream position 82 to winding position 84 and from winding position 84 to downstream position 88. Likewise, when the pivot arm 160, 164 is in the downward position its opposed slots 176 align with the opposed slots 138 of its adjacent gripping arms for sliding the winding pallet therebetween. In one embodiment the pivot arm 160, 164 and its associated lever arm 172 and pneumatic cylinder assembly 174 may be mounted to frame structures 180 and 182 which in turn are mounted on a track 184 enabling the pivot arm to be moved from its working position shown in Fig. 8 away from the conveyor lane 56 (to the left in Fig. 8) in order to provide access to the winding head assembly. A suitable belt drive or other arrangement could be provided for movement along the track 184. The winding head assembly may include side portions 190 and 192 between which the winding pallet 14 is positioned during winding. Each portion 190 and 192 may include an associated shroud assembly which is moved toward the stator during winding and one portion 190 would also include an associated winding needle and wire feed out arrangement to perform the actual winding operation. The upstream pivot arm 160 may also include structure 194 for supporting the insulation of the stator assembly in the winding pallet 14. Suitable proximity switches or other sensors may be provide with each pivot arm for control purposes to identify the pivot arm up and down positions.

Referring now to Fig. 9, downstream looking elevation view of the winding pallet 14 when in position 82 is shown. Once pivoted into the illustrated position an actuator 200 including a stator engaging head 202 may be moved into contact with the stator 22 to move the stator in direction 204 into a winding reference position relative to the winding pallet 14. The linear actuator 200 may again be formed by a pneumatic cylinder assembly. Movement of the stator 22 to a winding

reference position relative to the winding pallet 14 places the stator 22 in a desired position for winding at the winding position. It is recognized that in some cases the stator 22 may always be mounted in a winding reference position relative to the pallet in which case such an adjustment would not be necessary. Also shown in Fig. 9 is
5 another linear actuator 206, such as another pneumatic cylinder assembly, mounted for moving the winding pallet from the illustrated position 82 to the winding position 84 (into the page in the view shown). Again, suitable proximity switches or other sensors may be provide for control purposes to identify actuator 200 extend and retract positions and actuator 206 extend and retract positions.

10 A top schematic view of upstream position 82, winding position 84 and downstream position 88 is shown in Fig. 10. A winding pallet 14 is shown in the winding position 84. In one embodiment movement of the winding pallet 14 from the winding position 84 to the downstream position 88 of downstream pivot arm 164 is achieved utilizing a linear actuator 210 (such as a pneumatic arrangement) which may
15 include a pin portion 212 which can be pneumatically extended into a corresponding opening 29 (Fig. 1) on the winding pallet 14. Once the pin portion 212 engages the winding pallet 14, a linear actuator 214 such as a pneumatic cylinder arrangement can be utilized in a pulling operation of the linear actuator 210 to move the winding pallet into the downstream pivot arm 164. It is recognized that it is possible that such
20 movement could also be achieved in other ways such as by allowing a next to load winding pallet being moved from upstream position 82 to winding position 84 to contact and push the just wound winding pallet 14 at winding position 84 to downstream position 88.

Once a winding pallet is moved to downstream pivot arm 164 and
25 pivoted down into position 94, a push-type linear actuator mounted upstream of position 94 is used to slide the winding pallet 14 into the inwardly positioned gripping arms at pallet recombining position 96. In this regard reference is made to the partial schematic of Fig. 11 where the downstream pivot arm 164 is shown in part in its downward pivoted position to place the winding pallet 14 at position 94. Also shown
30 are the downstream gripping arms 220. As shown, after the winding operation of the winding machine the stator coil leads 222 may be placed in retaining studs 24. Typically the coil leads 222 may include an excess of 1-3 inches of wire 223 beyond

that which extends to the retaining studs 24. The downstream gripping arms 220 may therefore have associated wire combing arms positioned thereon, each with one or more wire combing pins 226 positioned just laterally of the retaining studs 24 such that when the winding pallet 14 is slid into the gripping arms 220 any excess wire 223
5 extending laterally outward is moved into contact with the combing pins 226 to move the wire 223 inward toward the winding pallet 14 as shown by arrows 228. One combing pin 226 per side of the winding pallet 14 may be sufficient in some cases, while in other cases it may be desirable to utilize more than one. The combing operation helps assure the excess wire 223 is not in an overhang condition where it
10 could come into contact with some other structure during movement along the conveyor lane 56.

Once the winding pallet 14 is moved to the downstream gripping arms 220, the downstream elevator moves the transport pallet 12 up into position against the winding pallet 14 and during such movement contact between the die portion 40
15 of the transport pallet 12 and the stator 22 moves the stator 22 back into its original reference position relative to the winding pallet 14. The downstream gripping arms 220 are then disengaged and the downstream elevator lowered to place the winding pallet 14 on transport pallet 12 arrangement back onto the conveyor lane 56 for movement down the line 54 to a next station. Where the combing arms 224 are
20 mounted on the moving gripping arms 220 themselves, and where combing pins 226 are positioned adjacent the retaining studs 224, the outward release motion of the gripping arms 220 may further move the combing pins to pull the excess wire 223 further inward of the winding pallet 14.

The winding system and method hereinbefore described facilitates high
25 speed winding of multiple stators by permitting one winding pallet to be wound while a next winding pallet is being loaded in position 82 just upstream of winding position 84. Similarly, a winding operation on a next winding pallet can begin before a just wound pallet is ever placed back on the conveyor lane. Other advantages of the system and method are recognizable.

30 Although the invention has been described above in detail referencing the preferred embodiments thereof, it is recognized that various changes and

modifications could be made without departing from the spirit and scope of the invention.

For example, while the various linear actuators utilized in conjunction with the invention may be pneumatic cylinder arrangements, it is recognized that other linear actuators including but no limited to linear servo actuators such as ball screw type and linear motor type could be used and the hydraulically controlled linear actuators could be used. Further, while various of the linear actuator movements are shown or described as pushing movements, it is recognized that such pushing movements could likewise be pulling movements where the linear actuator would mounted at a different location relative to the move taking place. Likewise, and linear actuator movement described as a pull movement could in turn be a push movement.

Still further, while the pallet separation scheme shown in the illustrated embodiment involves a lift of both the transport pallet 12 and the winding pallet 14, it is recognized that other separation schemes could be used. For example, rather than lifting both the transport pallet 12 and the winding pallet 14, the gripping arms could be movable between a conveyor height and an upward position to simply hold the winding pallet 14 and lift it off the transport pallet 12. In such an arrangement the gripping arms might be brought down to the conveyor height after the transport pallet 12 reaches position 70 so that the biasing means 142 of the gripping arrangement could be brought into contact with the transport pallet 12. Alternatively, the gripping arrangement could already be at conveyor height when the transport pallet 12 moves into position 70 and the biasing means 142 could be configured to initially slidably engage the transport pallet 12. In another pallet separation scheme the pivot arm 160 could be mounted for both pivotal and vertical movement at position 70 so that the winding pallet 14 is moved into the opposed slots 176 of the pivot arm 160 when the transport pallet and winding pallet move into position 70. The pivot arm could then be lifted vertically and then pivoted. Further, in some case the vertical movement of the pivot arm 160 may not be necessary. In these variations position 70 would represent the pallet separation station. Similar variations are possible at the pallet recombining side of the system. In still another arrangement the transport pallet 12 could be formed with opposed slots for holding the winding pallet 14. When the pallet combination reaches position 70 the two pallets could be elevated and then the

winding pallet could be slid out of the transport pallet opposed slots and into the pivot arm (such as by use of a properly positioned linear actuator) in order to separate the winding pallet from the transport pallet. Such an arrangement might eliminate the need fro the gripping arms. Alternatively, when the pallet combination reaches
5 position 70 the combination could be stopped and the winding pallet slid out of the transport pallet opposed slots directly into a pivot arm. Again, similar variations at the downstream side of the system could be employed. All of the variations of this paragraph represent alternative means for combining or separating the winding pallet and transport pallet.

10 In addition, while the wire combing structure of the illustrated embodiment is shown in association with the downstream gripping arms, it is also recognized that a suitable combing structure could possibly be positioned for contacting the excess wire 223 when the winding pallet 14 is slid from the winding position 84 to downstream position 88.

15 What is claimed is: